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NATIONAL DAM SAFETY PROGRAM. LAKE TIMBERLINE DAM (MO 30156), UP--ETC(U)
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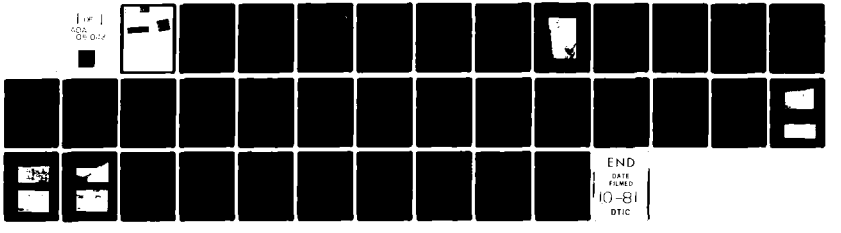

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	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Kenneth Balk and Associates, Inc.	8. CONTRACT OR GRANT NUMBER(s) DACW43-78-C-0169
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.	

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 NORTH 12TH STREET
ST. LOUIS, MISSOURI 63101

IN REPLY REFER TO

SUBJECT: Lake Timberline Dam Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Lake Timberline Dam.

It was prepared under the National Program of Inspection of Non-Federal Dams

This dam has been classified as unsafe, non-emergency by the St. Louis District as a result of the application of the following criteria:

1) Spillway will not pass 50 percent of the Probable Maximum Flood
2) Overtopping could result in dam failure.
3) Dam failure significantly increases the hazard to loss of life downstream

SUBMITTED BY: SIGNED
Chief, Engineering Division

18 MAR 1975
Date

APPROVED BY: SIGNED
Colonel, CE, District Engineer

8 MAR 1975
Date

LAKE TIMBERLINE DAM

ST. FRANCOIS COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30156

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

PREPARED BY

Kenneth Balk & Associates, Inc.
St. Louis, Missouri
Shannon & Wilson, Inc.
St. Louis, Missouri

PREPARED FOR

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

JANUARY, 1979

PHASE I REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam	Lake Timberline
State Located	Missouri
County Located	St. Francois County
Stream	Bee Run Creek
Date of Inspection	August 2, 1978

Lake Timberline Dam, No. 30156 was inspected using the "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed by the Chief of Engineers, U. S. Army, Washington, D.C., with the help of Federal and state agencies, professional engineering organizations, and private engineers. The resulting guidelines are considered to represent a consensus of the engineering profession.

Lake Timberline Dam was visually inspected by an interdisciplinary team of engineers from Kenneth Balk & Associates, Inc. and Shannon & Wilson, Inc. The purpose of the inspection was to make a preliminary assessment of the general condition of the dam with respect to safety in order to determine if, in the opinion of the interdisciplinary team, the dam poses recognizable hazards to human life or property. This assessment is based solely upon data made available and visual evidence observed during the site visit.

To make a complete assessment of the safety of the dam would require detailed studies and engineering analyses beyond the scope of this preliminary assessment.

Based on the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. The estimated damage zone extends eight miles downstream of the dam. Within the first half mile downstream of the dam are three low dams. Also within the damage zone are one farmhouse with outbuildings, one improved road crossing, one State highway bridge over Big River, and one large chicken farm complex. Lake Timberline Dam is in the intermediate size classification since it is greater than 40 feet high but less than 100 feet high.

The inspection and evaluation indicate that the spillway of Lake Timberline does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Lake Timberline is an intermediate size dam with a high hazard potential, required by the guidelines to pass the PMF. Considering the high hazard potential to loss of life and property downstream of the dam, the outlet facilities of Lake Timberline Dam should be able to pass the PMF without overtopping the dam. However, it was determined that the spillway will only pass approximately 15 percent (15%) of the PMF without overtopping the dam.

The evaluation of Lake Timberline also indicated that the spillway will pass the 100-year flood; that is, a flood having a 1 percent chance of being equalled or exceeded during any given year.

Deficiencies visually observed by the inspection team were seepage, erosion, a very thick cover of grass, small trees on the downstream slope, and a few small trees in the spillway outlet channel. Other deficiencies found were the lack of seepage records, operational records, seepage and stability analyses comparable to the requirements of the Recommended Guidelines, and seismic stability analyses.

It is recommended that action be taken in the near future to correct or control the deficiencies described. A detailed report discussing each of these deficiencies is attached.

Ervin H. Baumeyer, P.E.
Principal-In-Charge
Kenneth Balk and Associates, Inc.
St. Louis, Missouri

Lutz Kunze, P.E.
Principal Engineer
Shannon & Wilson, Inc.
St. Louis, Missouri

Overview of Lake and Dam

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM
LAKE TIMBERLINE DAM - ID NO. 30156

TABLE OF CONTENTS

APPENDIX

LIST OF PLATES

LIST OF PHOTOGRAPHS

SECTION 1 - PROJECT INFORMATION

1.1 GENERAL

a. Authority. The National Dam Inspection Act, Public Law 92-367, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a program of safety inspection of dams throughout the United States. Pursuant to the above, the St. Louis District, Corps of Engineers, District Engineer directed that a safety inspection of the Lake Timberline Dam be made.

b. Purpose of Inspection. The purpose of the inspection was to make an assessment of the general condition of the dam with respect to safety, based upon data made available and visual inspection, in order to determine if the dam poses hazards to human life or property.

c. Evaluation Criteria. Criteria used to evaluate the dam were furnished by the Department of the Army, Office of the Chief of Engineers, in "Recommended Guidelines for Safety Inspection of Dams". These guidelines were developed with the help of several Federal agencies and many State agencies, professional engineering organizations, and private engineers.

1.2 DESCRIPTION OF PROJECT

a. Description of Dam and Appurtenances.

(1) The dam is an earth structure built on Bee Run Creek in the northern part of St. Francois County, Missouri. Topography adjacent to the valley is rolling to steep. Most of the area in the vicinity of the dam is covered with a thick deposit of red silty clay. Topography in the vicinity of the dam is shown on Plate 1.

(2) A spillway is cut in dolomite (Potosi Formation) on the right abutment (west end of the dam).

(3) Pertinent physical data are given in paragraph 1.3 below.

b. Location. The dam is located in the northern portion of St. Francois County, Missouri, as shown on Plate 2. The lake formed by the dam is on the Missouri-St. Francois County Bonne Terre quadrangle sheet in the NW 1/4 of Section 24, T38N, R4E. Silver Springs is the nearest downstream city.

c. Size Classification. Criteria for determining the size classification of dams and impoundments are presented in the guidelines referenced in paragraph 1.1c above. Based on these criteria, this dam and impoundment is in the intermediate size category.

d. Hazard Classification. Guidelines for determining hazard classification are presented in the same guidelines as referenced in paragraph c. Based on referenced guidelines, this Corps of Engineers has determined that this dam is in the High Hazard Classification and thus has been selected by the Corps of Engineers for a Phase I inspection.

e. Ownership. This dam is owned by American Triad Corporation, 2006 Truman Boulevard, Crystal City, Missouri 63019.

f. Purpose of Dam. The dam forms a recreational lake.

g. Design and Construction History: The inspection team was unable to find any design or construction data. The dam was constructed by Black Excavating Co. of Crystal City, Missouri, in 1963, however, the team was unable to make contact with the contractor. Inspection reports by the Missouri Geological Survey dating from 1966 through 1969 indicate that the dam has experienced several leaks, a number of slides and the crest has undergone some settlement.

The slides were first noticed on February 26, 1968. Two slides were evident, one at the toe and the other 20 to 25 feet below the crest with some settlement of the crest evident. Repair work of the lower slide was underway on the M.G.S. visit of April 4, 1968 by dumping boulders at the toe. The upper slide was continuing to increase in size and the settlement of the crest at the center had also increased. Observation of the slides and remedial work continued thru 1968. The upper slide evidently was still moving and covered part of the rock berm at the toe. The last inspection report, dated March 13, 1969, states that all the remedial earthwork had been completed.

The next series of reports are by Reitz and Lens, Inc., dated October 1975 through February 1977 and these indicate that through seepage was visible at the toe of the dam. No further information was found.

h. Normal Operating Procedure. Normal rainfall, runoff, transpiration, and evaporation all combine to maintain a relatively stable water surface elevation.

1.3 PERTINENT DATA

a. Drainage Area - 1250 acres.

b. Discharge at Damsite.

(1) Rock spillway - 532 cfs. at maximum pool.

(2) Estimated experienced maximum flood - approximately two feet below top of dam.

c. Elevation (U.S.G.S.)

(1) Top of dam - 794± (see Plate 3).

(2) Spillway crest - 789.2.

(3) Streambed at centerline of dam - 715 (est.).

(4) Maximum tailwater - unknown.

d. Reservoir. Length of maximum pool - 3800 feet ±.

e. Storage (Acre-feet).

(1) Normal - 1199

(2) Maximum - 1464

f. Reservoir Surface (Acres).

(1) Top of dam - 54.

(2) Spillway crest - 42 (est.).

g. Dam.

(1) Type - earth embankment.

(2) Length - 700 feet.

(3) Height - 79 feet maximum.

(4) Top width - 20 feet.

(5) Side Slopes (Measured with a Brunton Compass in degrees and converted to ratios)

(a) Downstream - 3 H to 1 V.

(b) Upstream - 4 H to 1 V.

(6) Zoning - unknown

(7) Impervious core - unknown

(8) Cutoff - unknown

(9) Grout curtain - unknown

h. Diversion and Regulating Tunnel. - None.

i. Spillway.

(1) Type - rock

(2) Length of Weir - 16 feet.

(3) Crest elevation - 789.2 feet.

j. Regulating Outlets. - None.

SECTION 2 - ENGINEERING DATA

2.1 DESIGN

No design data were found to be readily available.

2.2 CONSTRUCTION

The dam was completed in 1963 by Black Excavating Co. of Crystal City. The inspection team was unsuccessful in contacting the builder.

2.3 OPERATION

No records of the maximum loading on the dam were available.

2.4 EVALUATION

a. Availability. No engineering data were readily available, with exception of the reports quoted in Section 1. A Geologic Report and several inspection reports prepared by the Missouri Geological Survey were made available.

b. Adequacy. No engineering data was available to make a detailed assessment of the design, construction, and operation. Seepage and stability analyses comparable to the requirements of the 'Recommended Guidelines for Safety Inspection of Dams' were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity. No engineering data or design were available. The geologic data was considered valid.

SECTION 3 - VISUAL INSPECTION

3.1 FINDINGS

A. General. A visual inspection of the Lake Timberline Dam was carried out on August 2, 1978. Personnel making the inspection were employees of Kenneth Balk and Associates, Inc. and Shannon and Wilson, Inc. of St. Louis and included civil, geotechnical, and structural engineers and an engineering geologist. Specific observations are discussed below.

B. Dam. The inspection team observed the following at the dam. The dam is an earth structure with unpaved road running across the crest. No detrimental settlement, depressions, sloughing, cracking, erosion or other slope instability was observed on or near the embankment. A two (2) foot deep erosion gulley was found downstream of the dam on the left abutment.

The downstream slope of the dam was covered with thick grass, some brush and several small trees. Only one animal burrow was found high on the downstream face of the dam, however others may be hidden by the thick grass cover.

Multiple small seeps were observed along the toe of the dam and the area downstream is soft and marshy. The upstream slope has a cover of light rip rap, gravel to 4 inch rock, without an apparent filter, and a grass cover.

The adequacy of the rip rap could not be assessed visually.

C. Appurtenant Structures. A spillway is cut into dolomite on the right abutment. The uncontrolled spillway was the only structure existing at this dam to control pool level. Some water was flowing over the spillway on the day of inspection.

The spillway outlet channel is cut into moderately competent dolomite. A number of small trees and weeds are growing on it.

D. Abutments. The dam intersects a high right abutment at right angles. The left abutment is lower than the right abutment. The juncture is not well defined and the dam curves upstream.

E. Reservoir Area. No wave wash, excessive erosion or slides were observed along the shore at the reservoir.

F. Dam Site Geology.

Left Abutment: The left abutment of the dam and the surrounding area upstream and downstream are covered with a thick layer of red, residual silty clay. No outcrop of bedrock is present.

Right Abutment: Three outcrops of the bedrock are exposed. Two are about 100' to 150' and the third is about 800 feet downstream of dam on the right abutment. The remainder of the abutment is covered with red, residual clay. Exposed bedrock consists of moderately weathered gray to brownish gray medium to fine grained, massively compacted, thickly bedded, moderate to closely jointed dolomite belonging to the Potosi Formation containing an abundance of quartz druse. The rock is typically brownish gray but weathered to light gray.

Four sets of joints have been observed:

dip 75^{o} - 80^{o}	strike 65^{o} NW
dip verticle	strike 60^{o} NW
dip 80^{o}	strike 40^{o} NW
dip vertical	strike NW

Some joints are horizontal. Openings in the joints range from 1/8" to 1/4" in general, but some are 4 inches wide. Most of the joints are coated with quartz crystals, a few are open joints. Surface joints are filled with red clay. Joint spacing is moderate with about 30 percent open and 70 percent closed joints.

Spillway: A spillway has been cut through the bedrock on the right abutment. Bedrock exposed in parts of spillway and outlet channel consists of dolomite (Potosi Formation of the upper Cambrian Series), gray, moderately weathered, medium to fine grained, massive and moderately to closely jointed having an abundance of quartz druse. Pattern of joints is similar to those found in outcrops on right abutment. These joints have been filled with red clay.

3.2 EVALUATION

The brush and small trees should be removed from the dam slopes and spillway outlet channel, since they encourage wildlife which may include burrowing animals. Seepage, if left uncontrolled, may adversely affect the stability of the dam. The erosion resistance on the upstream face is considered adequate for a dam of this size.

In the opinion of the inspection team, the services of a professional engineer experienced in the design of dams should be obtained to evaluate the deficiencies noted.

SECTION 4 - OPERATIONAL PROCEDURES

4.1 PROCEDURES

No regulating structures exists to control the lake level.

4.2 MAINTENANCE OF DAM

No maintenance records of the dam were available. However, regular mowing of the slopes is evident. Clearing of vegetation in the spillway outlet channel appears to be on a less regular basis.

4.3 MAINTENANCE OF OPERATING FACILITIES

No operating facility exists at this dam.

4.4 DESCRIPTION OF ANY WARNING SYSTEM IN EFFECT

The inspection team is not aware of any existing warning system for this dam.

4.5 EVALUATION

More careful mowing near the crest and a regular clearing of vegetation from the spillway outlet channel is desirable.

SECTION 5 - HYDRAULIC/HYDROLOGIC

5.1 EVALUATION OF FEATURES

a. Design Data. There were no hydraulic and hydrological design data made available.

b. Experience Data. The drainage area and lake surface area are developed from USGS Bonne Terre, Mo. Quadrangle. The spillway and dam layout are from surveys made during the inspection.

c. Visual Observations. Rock spillway and falls at outlet channel, except as noted in Section 3, are in good condition. Spillway discharges, as noted in Section 3, may eventually endanger the integrity of the dam.

d. Overtopping Potential. The spillway has been found to be inadequate to pass the Probable Maximum Flood (PMF) without overtopping the dam. The probable maximum flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region.

For the PMF, the dam would be overtopped to a maximum height of approximately 5.5 feet with a duration of overtopping of approximately 11 hours with a maximum discharge rate of approximately 13,720 cfs. In our opinion, failure of the dam may be expected to occur as a result of overtopping for this length of time.

For 50% of the PMF, the dam would be overtopped to a height of approximately 3 feet, with a duration of overtopping of approximately 7.6 hours, with a maximum discharge rate of approximately 5990 cfs.

The spillway has been found to be adequate to pass a flood of approximately fifteen percent (15%) of the PMF.

The spillway has been found to be adequate to pass the 100-year flood, which has a 1% chance of being equalled or exceeded at least once during any given year.

The estimated damage zone extends eight miles downstream of the dam. Within the first half mile downstream of the dam are three low dams. Also within the damage zone are one farmhouse with outbuildings, one improved road crossing, one State highway over Big River, and one large chicken farm complex.

SECTION 6 - STRUCTURAL STABILITY

6.1 EVALUATION OF STRUCTURAL STABILITY

a. Visual Observations. Visually observed conditions which can affect the structural stability of this dam have been discussed in Section 3, paragraph 3.1 b.

b. Design and Construction Data. No design or construction data relating to the structural stability of the dam were found.

c. Operating Records. No records were available. The lack of seepage and stability analyses comparable to the requirements of the recommended guidelines is a deficiency which should be corrected.

d. Post-Construction Changes. No post-construction changes were observed which would effect the structural stability of the dam.

e. Seismic Stability. The location of Lake Timberline Dam is in Seismic Zone 2. In the opinion of the inspection team, since no engineering data was available, the services of a professional engineer experienced in the design of dams should be obtained to evaluate the seismic stability of this dam.

SECTION 7 - ASSESSMENT/REMEDIAL MEASURES

7.1 DAM AND SPILLWAY ASSESMENT

a. Safety.

(1) Dam. Corrective measures should be taken for the deficiencies visually observed by the inspection team, i.e. brush on the upper embankment and trees in the sides of the spillway outlet channel and seepage which left uncontrolled could lead to an unsafe condition. The one (1) animal burrow observed high up on the slope, in our opinion, is not considered significant. Seepage and stability analyses comparable to the requirements of the 'Recommended Guidelines for Safety Inspection of Dams' were not available, which is considered a deficiency.

(2) Spillway. The spillway does not meet the criteria set forth in the guidelines without overtopping the dam, which is considered a deficiency.

b. Adequacy of Information. Due to the lack of engineering design and construction data, except that discussed in Section 1, the conclusions of this report were based on performance and external visual conditions. A geological report and several inspection reports, prepared by the Missouri Geological Survey were available and were considered in the preparation of this report. The lack of seepage and stability analyses comparable to the requirements of the recommended guidelines is a deficiency which should be corrected. The inspection team considers that these data are sufficient to support the conclusions herein.

7.2 REMEDIAL MEASURES

a. O&M Procedures. The following O&M procedures are recommended:

(1) Trees and excessive vegetation should be removed from the upstream and downstream slopes and the spillway outlet channel.

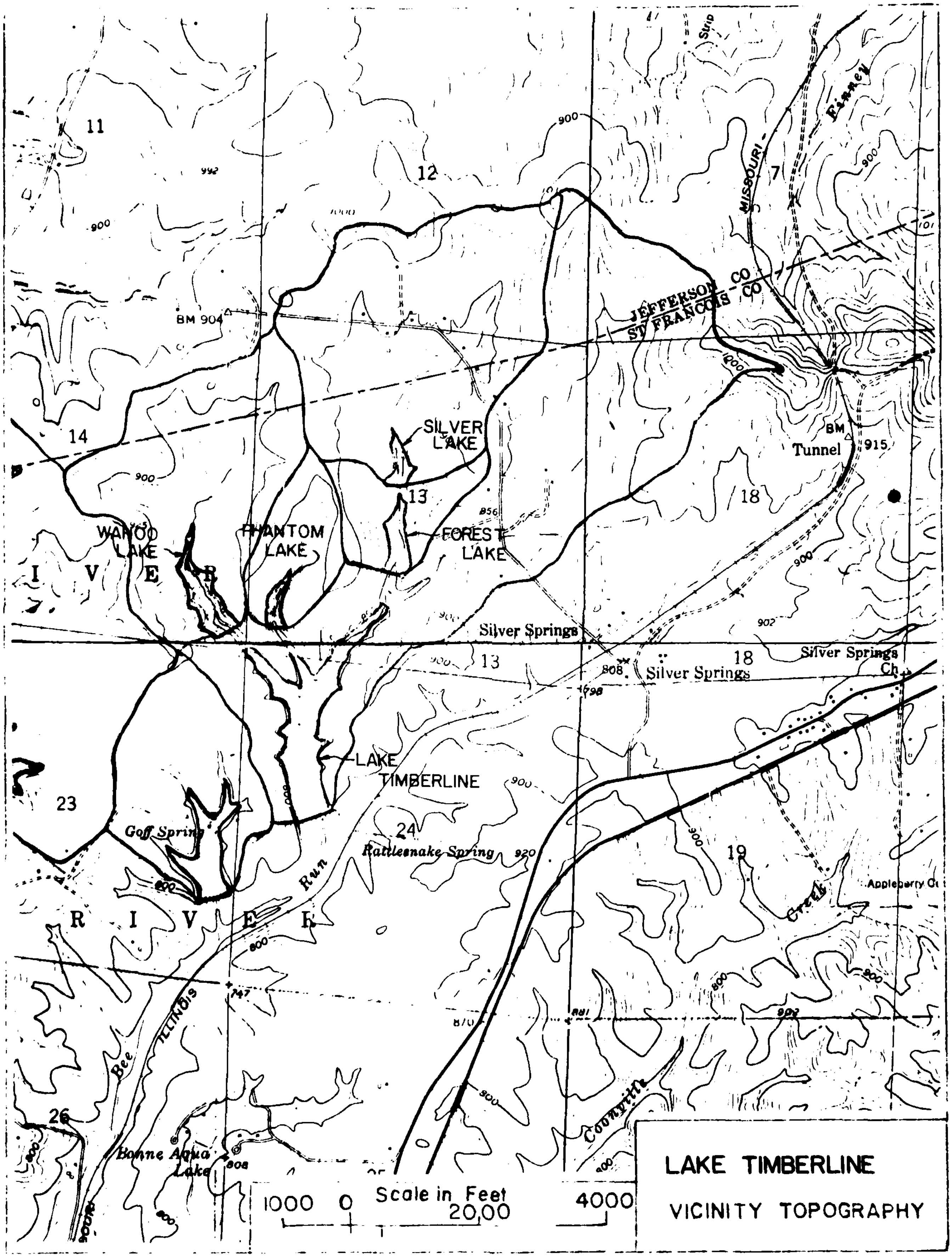
(2) Seepage should be monitored to determine the quantity of flow and sedimentation, and corrective measures should be designed based on appropriate analyses.

(3) Spillway capacity and/or height of dam should be increased in order to pass 100% of the PMF.

(4) Up-to-date records of all future maintenance and repairs should be kept.

(5) An engineer experienced in dam design should be retained to evaluate the stability of the dam in view of the steep slopes.

(6) A periodic inspection of the dam by a professional engineer experienced in dam design is recommended.



LAKE TIMBERLINE

VICINITY TOPOGRAPHY

PLATE I

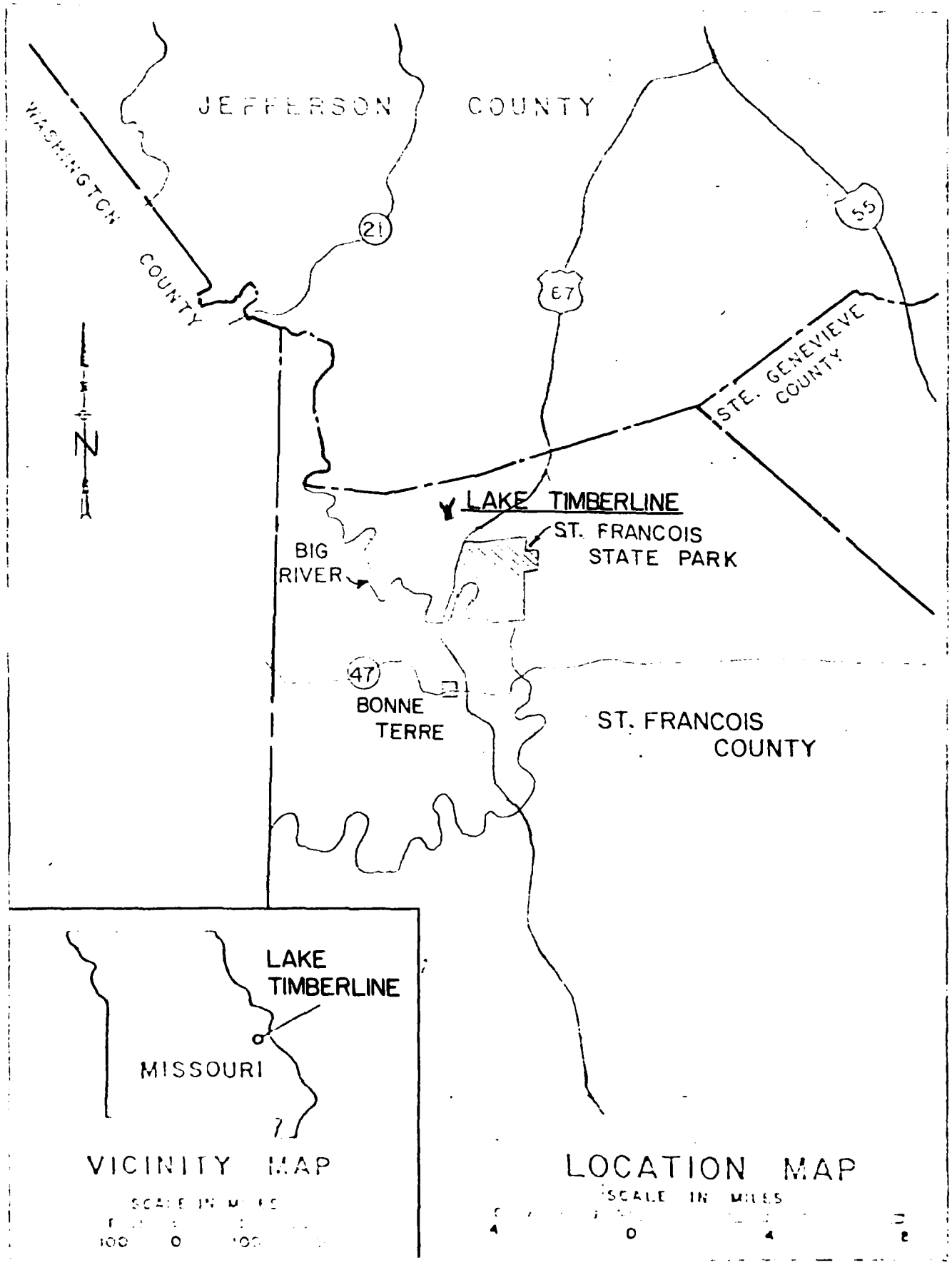
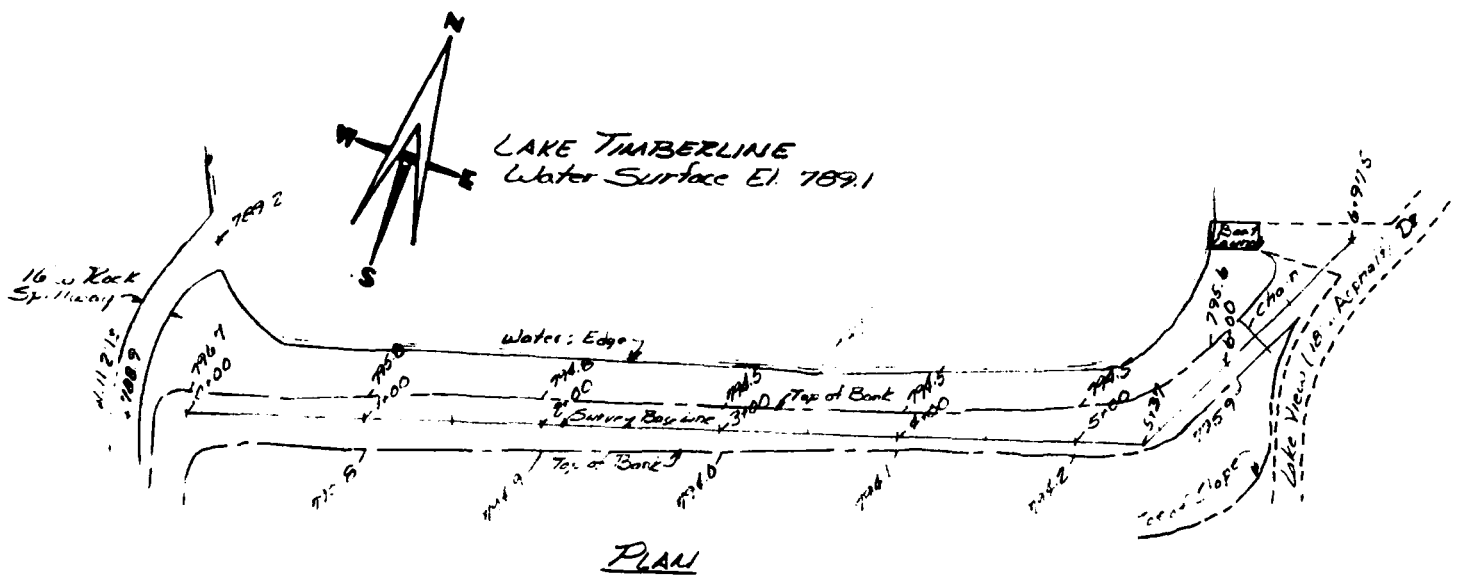

JEFFERSON COUNTY
WASHINGTON COUNTY
21
67
55
STE. GENEVIEVE COUNTY
N
LAKE TIMBERLINE
ST. FRANCOIS STATE PARK
BIG RIVER
47
BONNE TERRE
ST. FRANCOIS COUNTY
LAKE TIMBERLINE
MISSOURI
VICINITY MAP
SCALE IN MILES
100 0 100
LOCATION MAP
SCALE IN MILES
4 0 4 8

PLATE 2



PLAN

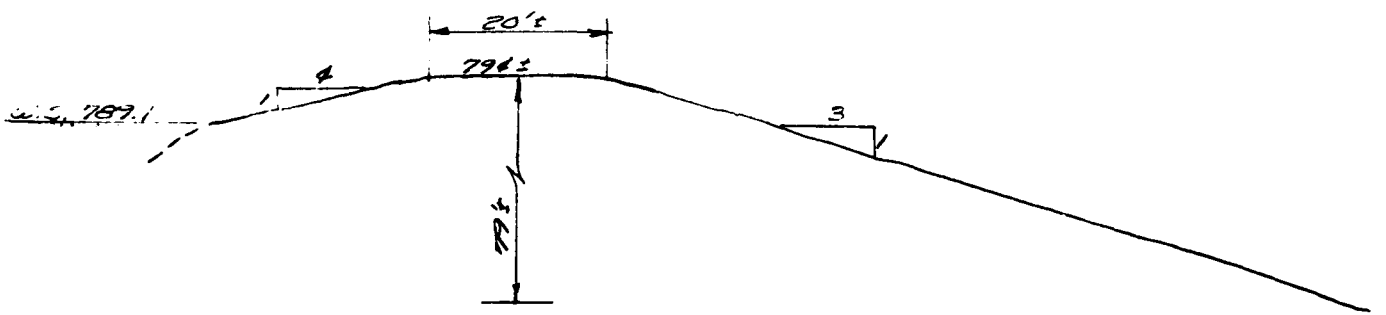
LAKE TIMBERLINE

TOP OF DAM ELEVATIONS

SCALE: 1"=100±

PLATE 3

PROFILE
1"=200' Horiz
Scale: 1"=10' Vert.



TYPICAL CROSS SECTION
Scale: 1"=20' Horiz & Vert.

LAKE TIMBERLINE
DAM PROFILE
and CROSS SECTION

PLATE 4

PHOTO 1: Overview of Lake and Dam.

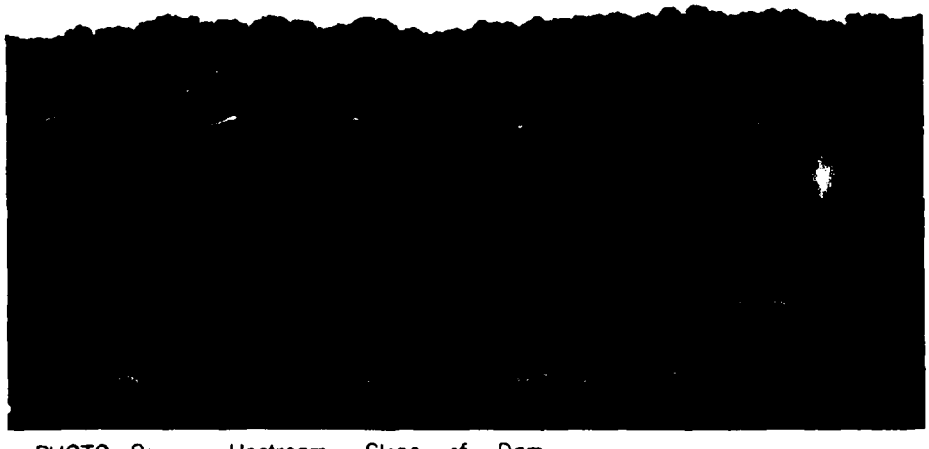


PHOTO 2: Upstream Slope of Dam

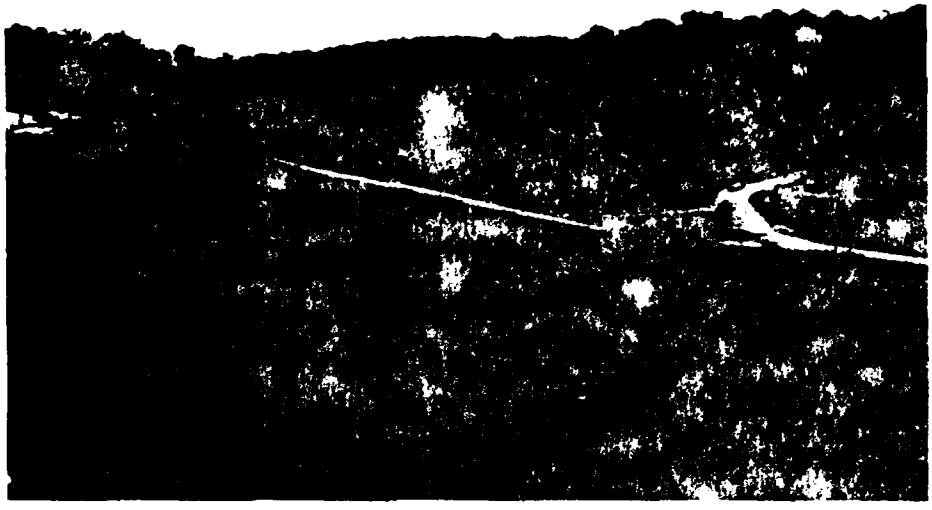


PHOTO 3: Downstream Slope of Dam from East Bank of Spillway.

PHOTO 4: View of Downstream Toe from Station 3+00.

PHOTO 5: Spillway Entrance Looking South from Lake.

PHOTO 6 Rock Outcroping on West side of Spillway.

APPENDIX A

HYDROLOGIC AND HYDRAULIC ANALYSIS METHODOLOGY

HYDROLOGIC AND HYDRAULIC ANALYSIS METHODOLOGY

1. The hydrologic analysis used in development of the overtopping potential is based on applying a hypothetical storm to a unit hydrograph to obtain the inflow hydrograph for a reservoir routing. The Probable Maximum Precipitation is derived and determined from regional charts prepared by the National Weather Service in "Hydrometeorological Report No. 33." Reduction factors have not been applied. A 24-hour storm duration is assumed with the total rainfall depth distributed over 6-hour periods in accordance with procedures outlined in EM 1110-2-1411 (SPF Determination). The maximum 6-hour rainfall period is then distributed to hourly increments by the same criteria. Within-the-hour distribution is based upon NOAA Technical Memorandum NWS HYDRO-35. The nonpeak 6-hour rainfall periods are distributed uniformly. All distributed values are arranged in a critical sequence by the SPF criteria. The final inflow hydrograph is produced by utilizing the Soil Conservation Service dimensionless unit hydrograph using Hydrologic Soils Groups "B", Antecedent Moisture Condition III, and SCS CN 82 used to determine rainfall excess.

Lag time was estimated using methods outlined in "Design of Small Dams", by the United States Department of The Interior, Bureau of Reclamation. Using this source, lag time is taken as 60% of the time of concentration.

Time of concentration was estimated utilizing methods outlined in the source quoted above, supplemented by data obtained during field investigation. The results of the field investigation indicated that a time of 45 minutes should prevail over any lesser value obtained using the methods outlined in the quoted source. For this lake, a lag time of 0.45 hours was therefore computed.

2. The reservoir routing is accomplished by using Modified Puls routing techniques wherein the flood hydrograph is routed through lake storage. Hydraulic capacities of the outlet works, spillway, and crest of dam are used as outlet controls in the routing. Storage in the pool area is defined by an elevation-storage capacity curve. The hydraulic capacity of the outlet works, spillway, and top of dam are defined by elevation-discharge curves.

3. Dam overtopping analysis has been conducted by hydrologic methods for this dam and lake. This computation determines the percentage of the PMF hydrograph that the reservoir can contain without the dam being overtopped. An output summary in the hydrologic appendix displays this information as well as other characteristics of the simulated dam overtopping.

4. The above methodology has been accomplished for this report using the systemized computer program HEC-1 (Dam Safety Version), July 1978, prepared by the Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, California. The numeric parameters estimated for this site are listed in the attached computer printout. Definitions of these variables are contained in the "User's Manual" for the computer program.

5. The inflow hydrograph was routed through the reservoir using HEC-1's Modified Puls option. Releases were calculated for: 1) the spillways, and, 2) the flow over the top of the dam. These releases were then combined at each of their respective elevations.

Flow through the rock spillway was calculated by writing the Bernoulli equation between the lake water surface and the energy gradient elevation in the channel.

With flow in the channel at normal depth, and using the lake water surface as the datum, and, assuming velocity of approach to be zero, the following equation is written:

$$H = E.G. + h_e$$

Where H = difference between lake water surface and the Energy Gradient Elevation in the channel,

E.G. = Energy Gradient Elevation in the channel = depth of flow + $\frac{V^2}{2g}$

h_e = Entrance loss = $k_e \frac{V^2}{2g}$

Where $k_e = 0.5$

The equation can then be simplified as follows:

$$\text{Stage} = I.E. + d_f + 1.5 \frac{V^2}{2g}$$

Where I.E. = Invert Elevation = normal pool elevation

d_f = normal flow depth for a given discharge, obtained by the Manning Equation

Stage = Pool elevation

Flow over the top of dam was calculated using the weir flow equation:

$$Q = CL(H)^{1.5}$$

where: C = Varies with head as outlined in "Handbook of Hydraulics" by Horace Williams King, revised by Ernest F. Brater.

L = Length in feet (varies with water surface)

H = Head of water in feet (varies with water surface)

Q = Discharge in cfs

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  11 JAN 79
**********
    1                A1       LAKE     TIMERLINE       MULTI   RESERVOIR     ROUTING
    2                A2                          JAN,     1979
    3                A3                    MO.  INV.    NO.  30156
    4                B    288       0        5        0        0        0        0        0       -4        0
    5                R1     5
    6                J       1        6        1
    7                J1   0.10     0.15     0.20     0.30     0.50     1.00
    8                K       0  INFLOW                             0        0
    9                K1        SUBAREA RUNOFF FOR SILVER LAKE
   10                M       1        2     .49                             1                          1
   11                P                26      100      120      130
   12                T                                                                 -1      -82              .05
   13                W2               .19
   14                X     .98       -.1        3
   15                K       1 ROUTING                          0        0        1
   16                K1         RESERVOIR ROUTING FOR SILVER LAKE
   17                Y                                     1        1
   18                Y1      1                                                  -839.8       -1
   19                Y4 839.8    840.0    841.0    842.0    843.0    844.0    845.0    846.0    847.0    848.0
   20                Y4 849.0    850.0
   21                Y5      0      7.0    100.6    248.9    436.6    656.5    904.4   1177.4   1791.4   3381.2
   22                Y5 980.5   6503.1
   23                $S      0     1.10     6.92    13.40    20.52    28.28    36.68    45.72    55.40    65.72
   24                $S 76.69    88.31
   25                $E 839.8    840.0    841.0    842.0    843.0    844.0    845.0    846.0    847.0    848.0
   26                $E 849.0    850.0
   27                $$ 839.8
   28                $D 846.2
   29                K       0  INFLOW                             0        0        1
   30                K1        SUBAREA RUNOFF FOR FOREST LAKE
   31                M       1        2    .093                             1                          1
   32                P                26      100      120      130
   33                T                                                                 -1      -82              .05
   34                W2               .17
   35                X     .19       -.1        3
   36                K       2                                  0        0        1
   37                K1         SILVER LAKE AND FOREST LAKE COMBINED
   38                K       1 ROUTING                          0        0        1
   39                K1 RESERVOIR ROUTING FOR FOREST LAKE
   40                Y                                     1        1
   41                Y1      1                                                  -823.6       -1
   42                Y4 823.6    824.0    825.0    826.0    827.0    828.0    829.0    830.0    831.0    832.0
   43                Y4 833.0    834.0    835.0
   44                Y5      0      5.0     37.7     99.8    188.9    309.5    463.3    652.8    886.8   1590.1
   45                Y5 3172.2   5288.7   7823.3
   46                $S      0      4.3     15.6     27.7     40.7     54.6     69.4     85.0    101.5    118.9
   47                $S 137.2    156.3    176.3
   48                $E 823.6    824.0    825.0    826.0    827.0    828.0    829.0    830.0    831.0    832.0
   49                $E 833.0    834.0    835.0
   50                $$ 823.6
```

COMPUTER INPUT DATA

```
51  SD 830.9
52  K       0  INFLOW                                   0       0       1
53  K1       SUBAREA RUNOFF FOR PHANTOM LAKE
54  M        1       2     .106                                1                       1
55  P                   24      100      120      130
56  T                                                                -1      -82                    .05
57  W2                .17
58  X    .212       -.1        3
59  K       1 ROUTING                                   0       0       1
60  K1     RESERVOIR ROUTING FOR PHANTOM LAKE
61  V                                           1       1
62  Y1       1                                                      -823.7      -1
63  Y4 823.7    824.0    825.0    826.0    827.0    828.0    829.0    830.0    831.0    832.0
64  Y5       0      1.0      6.8     17.1     31.5     49.4    424.8   1048.3   1680.1   2392.6
65  S5       0      1.1      4.9      8.9     13.1     17.6     22.3     27.2     32.4     37.8
66  SE 823.7    824.0    825.0    826.0    827.0    828.0    829.0    830.0    831.0    832.0
67  SS 823.7
68  SD 827.7
69  K       2
70  K       0  INFLOW                                   0       0       1
71  K1       SUBAREA RUNOFF FOR WAHOO LAKE
72  M        1       2     .39                                 1                       1
73  P                   26      100      120      130
74  T                                                                -1      -82                    .05
75  W2                .20
76  X     .78       -.1        3
77  K       1 ROUTING                                   0       0       1
78  K1       RESERVOIR ROUTING FOR WAHOO LAKE
79  V                                           1       1
80  Y1       1                                                      -829.9      -1
81  Y4 829.9    830.0    831.0    832.0    833.0    834.0    835.0    836.0    837.0    838.0
82  Y4 839.0
83  Y5       0      2.2     24.3     77.6    122.8    219.4    386.4    792.5   2176.0   3344.3
84  Y56443.5
85  S5       0     7.85     21.6     36.0     51.3     67.4     84.2    101.8    120.2    139.4
86  SS 159.3
87  SE 829.9    830.0    831.0    832.0    833.0    834.0    835.0    836.0    837.0    838.0
88  SE 839.0
89  SS 829.9
90  SD 835.0
91  K       2
92  K       0  INFLOW                                   0       0       1
93  K1       SUBAREA RUNOFF FOR LAKE TIMBERLINE
94  M        1       2     .88                                 1                       1
95  P                   26      100      120      130
96  T                                                                -1      -82                    .05
97  W2                .45
98  X    1.76       -.1        3
99  K       2                                           0       0       1
100 K1   FOREST LAKE PHANTOM LAKE WAHOO LAKE AND LAKE TIMBERLINE COMBINED
```

COMPUTER INPUT DATA

```
101    K      1 ROUTING                            0         0         1
102    K1      RESERVOIR ROUTING FOR LAKE TIMBERLINE
103    Y                               1         1
104    Y1     1                                           -789.2      -1
105    Y4 789.2    790.0    790.5    791.0    791.5    792.0    792.5    793.0    793.5    794.0
106    Y4 794.5    795.0    795.5    796.0    796.5    797.0    797.5    798.0
107    Y5     0    18.57    41.24    71.93   111.88   171.54   219.63   283.47   364.66   445.85
108    Y5552.93   783.28  1167.71  2010.25  3011.56  4638.68  6278.42   7860.0
109    $S     0    38.11    62.40    87.04   112.03   137.38   163.09   189.15   215.57   242.35
110    $S269.48   296.96   324.81   353.00   381.56   410.46   439.73   469.50
111    $E 789.2    790.0    790.5    791.0    791.5    792.0    792.5    793.0    793.5    794.0
112    $E 794.5    795.0    795.5    796.0    796.5    797.0    797.5    798.0
113    $$ 789.2
114    $D 794.4
115    K     99
```

COMPUTER INPUT DATA

SUMMARY OF DAM SAFETY ANALYSIS

PLAN 1 .....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	789.20	789.20	794.40
STORAGE	0.	0.	264.
OUTFLOW	0.	0.	532.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.10	792.72	0.00	174.	247.	0.00	19.17	0.00
.15	794.14	0.00	250.	475.	0.00	18.58	0.00
.20	795.12	.72	304.	678.	3.83	18.17	0.00
.30	796.10	1.70	359.	2217.	5.33	16.58	0.00
.50	797.41	3.01	435.	5990.	7.58	16.17	0.00
1.00	799.85	5.45	580.	13720.	11.00	16.08	0.00

12

COMPUTER SUMMARY PAGE 1 OF 2